What is claimed is:

1. A DC brushless motor controller which handles a DC brushless motor by converting the DC brushless motor to an equivalent circuit having a q-axis armature which resides on a q-axis which constitutes a direction of magnetic flux of a field of the motor and a d-axis armature which resides on a d-axis which intersects with the q-axis at right angles, the controller comprising:

a current detecting unit for detecting current which flows to the armatures of the motor;

a dq actual current calculating unit for calculating a q axis actual current which flows to the q axis armature and a d axis actual current which flows to the d axis armature based on a current value detected by the current detecting unit and a rotor angle of the motor; and

an energizing control unit for feedback controlling the amount of electrical energy supplied to the armatures of the motor by generating a d axis voltage applied to the d axis armature and a q axis voltage applied to the q axis armature in such a manner as to reduce a q axis current deviation which is a deviation between a q axis command current which is a command value of current flowing to the q axis armature and the q axis actual current and a d axis current deviation which is a deviation between a d axis command current which is a command value of current

flowing to the d axis armature and the d axis actual current, the energizing control unit including

a reference values calculating unit for feedback controlling the amount of electrical energy supplied to the armatures of the motor in a predetermined control cycle, implementing a unidirectional feedback control which generates a d axis voltage and a q axis voltage in the current control cycle using the d axis actual current and the q axis actual current which are calculated based on an estimate value (θ′) of the rotor angle of the motor by the dq actual current calculating unit relative to each of two or more directions which are represented by a linear combination of unit vectors of respective coordinate axes in an orthogonal coordinates system in which the d axis voltage and the q axis voltage constitute coordinate axes thereof and which are not parallel to each other in different control cycles in such a manner that the size of a vector in which the d axis voltage and the q axis voltage which were generated in the previous control cycle constitute components of the vector increases or decreases along the two or more directions according to the d axis current deviation and the q axis current deviation when the vector is projected in the two or more directions, and calculating a sine reference value which corresponds to a sine value of an angle which

is twice a phase difference ($\theta-\theta'$) between an actual value (θ) and an estimate value (θ') of the rotor angle of the motor and a cosine reference value which corresponds to a cosine value of the angle which is twice the phase difference ($\theta-\theta'$) based on variations of the d axis actual current and the q axis actual current and levels of the d axis voltage and the q axis voltage in a control cycle in which the unidirectional feedback control is implemented to each of the two or more directions, and

a rotor angle detecting unit for detecting a rotor angle of the motor based on the sine reference value and the cosine reference value so calculated.

2. A DC brushless motor controller as set forth in Claim 1, wherein the two or more directions are two coordinate axes directions of the orthogonal coordinates system in which the d axis voltage and the q axis voltage constitute coordinate axes thereof.

3. A DC brushless motor controller as set forth in Claim 2, wherein the rotor angle detecting unit calculates the sine reference value and the cosine reference value by the following equations (1) to (7),

[Equation 1]

$$\begin{bmatrix} \hat{V}s \\ \hat{V}c \\ \hat{V}l \end{bmatrix} = \begin{bmatrix} L_1 \sin 2\theta e \\ L_1 \cos 2\theta e \\ Lo \end{bmatrix} = (\tilde{C}^t \tilde{C})^{-1} C^t \begin{bmatrix} \dfrac{dd\hat{I}\,(i_1)}{d\hat{V}d\,(i_1)} \\ \dfrac{dd\hat{I}\,(i_2)}{d\hat{V}q\,(i_2)} \end{bmatrix} \equiv \tilde{D} \begin{bmatrix} \dfrac{dd\hat{I}\,(i_1)}{d\hat{V}d\,(i_1)} \\ \dfrac{dd\hat{I}\,(i_2)}{d\hat{V}q\,(i_2)} \end{bmatrix} \cdots\cdots (1)$$

[Equation 2]

$$L_1 = \frac{1}{2}\left(\frac{1}{Ld} - \frac{1}{Lq}\right) \quad \cdots\cdots\cdots\cdots (2)$$

[Equation 3]

$$Lo = \frac{1}{2}\left(\frac{1}{Ld} - \frac{1}{Lq}\right) \quad \cdots\cdots\cdots\cdots (3)$$

[Equation 4]

$$\tilde{C} = \begin{bmatrix} 0 & 1 & 1 \\ 1 & 0 & 0 \\ 1 & 0 & 0 \\ 0 & -1 & 1 \end{bmatrix} \quad \cdots\cdots\cdots\cdots (4)$$

[Equation 5]

$$dd\hat{I}d(i) = \begin{bmatrix} \dfrac{\Delta\hat{I}d(i+1)}{\Delta T} - \dfrac{\Delta\hat{I}d(i)}{\Delta T} \\ \dfrac{\Delta\hat{I}q(i+1)}{\Delta T} - \dfrac{\Delta\hat{I}q(i)}{\Delta T} \end{bmatrix}$$

$$= \begin{bmatrix} \dfrac{\hat{I}d(i+2)-\hat{I}d(i+1)}{\Delta T} - \dfrac{\hat{I}d(i+1)-\hat{I}d(i)}{\Delta T} \\ \dfrac{\hat{I}q(i+2)-\hat{I}q(i+1)}{\Delta T} - \dfrac{\hat{I}q(i+1)-\hat{I}q(i)}{\Delta T} \end{bmatrix} \quad \cdots\cdots\cdots (5)$$

[Equation 6]

$$d\hat{V}d(i) = \hat{V}d(i+1) - \hat{V}d(i) \quad \cdots\cdots\cdots (6)$$

[Equation 7]

$$d\hat{V}q(i) = \hat{V}q(i+1) - \hat{V}q(i) \quad \cdots\cdots\cdots (7)$$

where, Vs^: sine reference value, , Vc^: cosine reference value, i_1: control cycle in which the unidirectional feedback control is implemented relative to the d axis; i_2: control cycle in which the unidirectional feedback control is implemented relative to the q axis; Ld: inductance of the d axis armature; Lq: inductance of the q axis armature; ΔT: control cycle time; ΔId^(i): variation of the d axis actual current in a control cycle

i; $\Delta Iq\hat{}(i)$: variation of the q axis actual current in the control cycle i; $Id\hat{}(i)$: the d axis actual current in a control cycle i; $Iq\hat{}(i)$: the q axis actual current in the control cycle i; $dVd\hat{}(i)$: variation of the d axis voltage in the control cycle i; $Vd\hat{}(i)$: d axis voltage in the control cycle i; $dVq\hat{}(i)$: variation of the q axis voltage in the control cycle i; $Vq\hat{}(i)$: q axis voltage in the control i.

4. A DC brushless motor controller as set forth in Claim 3, wherein data of components of a matrix $D^{\sim}$ in the equation (1) are stored in a memory in advance, and wherein the rotor angle detecting unit executes an operation of the equation (1) using the data of the components of the matrix $D^{\sim}$ stored in the memory.